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## STEM For Establishing Energy Literacy in Maritime Vocational Education

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**a b s t r a c t**

The development of new and renewable energy is an essential issue in the 21<sup>st</sup> century that must be delivered to the community, and maritime vocational education has an urgency on the energy literacy for ship engineering cadets. However, learning about energy for engineering cadets still lacks attention. The purpose of this paper is to describe energy literacy, which is reviewed based on the cognitive and affective aspects of cadets in maritime vocational education. This research used the quasi-experiment method, which a total of 61 engineering cadets learned about energy use using the STEM approach. From the results was found that although the achievement of understanding energy literacy from pre-test to post-test score with a small increase but the attitude of cadets towards the importance energy education has 76%, energy-saving attitude on ships 71%, the use of renewable energy 68%, rules on energy use according to ANNEX it must be obeyed is 71%. These results illustrate that it is necessary to continue and add of learning time to increase the cognitive aspects of energy literacy and to improve awareness of the cadets' attitudes about the importance of saving energy and its utilization.

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### 1. Introduction

The Development of new and renewable energy is an essential issue in the 21<sup>st</sup> century that must be conveyed to the community (James et al., 1994). Additionally, the government's policy on energy, its aims are reducing the use of petroleum and increasing the use of gas and coal, as Presidential Decree no. 5 of 2006 focusing the Energy Mix on target at 2025 (Setiawan, 2009). According to Muna (2011) Energy issues are crucial to be faced by Indonesia in an increasingly competitive global world.

The State's contribution to reduce carbon emissions has an impact on policies for industries that have been emitting carbon gas. Industry players must have a role in actions and decisions for commitments to reduce carbon gas emissions through both workers and some types of equipment used. The purpose of workers for long-term endurance that the potentials of generation roles such as students.

Potential among students is the inculcation of energy literacy that can be included in the education curriculum (U.S. Department of Energy, 2013) as well as the blueprint test (Fives & DiDonato-Barnes, 2013). Through understanding, energy and energy literacy will be able

to provide provisions for students to act, socialize, decision-makers, and professionals when they are using energy and energy sources. For cadets officers in maritime vocational education have the urgency of energy literacy. The understanding and attitudes for cadets officers about energy and the use of energy is essential to educate because in general students, youth, and people do not understand about energy.

The results of a survey conducted by the National Environment Education and Training Foundation (NEETF) in 2001 that only 12% of young people in America over the age of 18 can answer correctly from the quiz (NEETF, 2002). Other data from the results of a survey conducted by the Massachusetts Institute of Technology (MIT) through internet-based public opinion on climate change and the environment found that more than 1200 respondents had never heard or read about hydrogen cars, wind energy, or nuclear energy. The fact is that as many as 17% of those surveyed have never heard of a term related to energy (Nowcast, 2005). Therefore, more than 20 educational partners and 13 federal institutions in US focus education on energy literacy (U.S. Department of Energy, 2013).

The definition of literacy can be model by assessing the results of work from activities that have been done as in the definition of technological literacy (ISTE, 2007). According to the International Technology Education Association and the International Association (ITEA) that the standardization of technological literacy includes the ability to use, organize, analyze, access, and understand technological systems for problem-solving, delivering and participating in social activities (ITEA, 2000).

While Roth expressed the literacy framework is an ability that includes four domains are knowledge, skill, affective, and behavior (Roth, 1992; Roth, 1996; DeWaters et al., 2007; 2013). Meanwhile, technological literacy based on the National Academic Education (NAE) and the National Research Council (NRC) reveals technological literacy has three domains there are knowledge, skills, and motivation, responsibility, self-readiness, activities, or habits of thought. The relationship between the framework of literacy, technological literacy, and energy literacy is summarized to arrange energy education, as shown in Figure 1.



attitudes (attitude and behavior), 3) knowledge (content knowledge), 4) reasoning, 5) knowledge of career/plans (career knowledge).

Some other discoveries are that schools can motivate students in higher education with STEM learning (Zamista, 2018) and the integration of STEM with real-world applications at work (National Research Council, 2010). That shows that through the STEM approach, it can be integrated into building energy literacy in engineering cadets in maritime vocational schools. The purpose of this study is to obtain the achievement of energy literacy by using STEM in establishing energy literacy, which is reviewed based on the cognitive and affective domains of engineering cadets in maritime vocational education.

## 2. Method

This study used a quasi-experimental method with the experimental design is a randomized control group pretest-posttest (Sugiyono, 2011). The first stage was carried out preliminary testing through a pre-test, then the researchers treated STEM approaches to the cadets in the AKMI Suaka Bahari Cirebon, totaling 61 peoples. The treatment of cadets was done by teaching, experiment, and doing projects. After the treatment process, the researchers then tested the achievement of understanding and attitudes of the energy literacy of the cadets through the post-test.

In this study, the sample uses a cluster sampling technique which is stratified random sampling. Samples taken from AKMI Suaka Bahari Cirebon cadets in each class amounted to 30 and 31 people from two classes.

## 3. Result and Discussion

Based on the results of cognitive tests on the understanding of energy literacy in engineering cadets as many as 61 people obtained pretest achievement, an average is 3.72, and post-test achievement an average is 4.25, as shown in Table 1.

Table 1. Achievements of pre-test and post-test understanding of the literacy of technical cadets

Score	Experiment Classes (N=61)	
	Pre-test	Post-test
An average	3,72	4,25
Deviation Standard	1,13	1,25

Table 1. shows that the post-test achievements there is an increase from the pre-test achievements before learning even though it is still on a small scale. The homogeneity test of

pre-test and post-test mean values with Levene test that the homogeneity of pre-test and post-test is obtained from a sig value of  $0.310 > 0.05$  ( $\alpha_{\text{Sign}} > 0.05$ ) and ANOVA test is showed in table 2.

Table 2. ANOVA test results of understanding of the energy literacy of cadets

ANOVA Understanding Achievement					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Group	8.65	1	8.658	6.073	.015
Within Group	171.07	120	1.426		
Total	179.72	121			

ANOVA test results that the difference between the average value of pre-test and post-test average, there is a significant difference obtained from the sign value  $0.015 < 0.05$  ( $\alpha_{\text{Sign}} < 0.05$ ). Testing the understanding of cadets about energy based on indicators is showed in Figure 2.

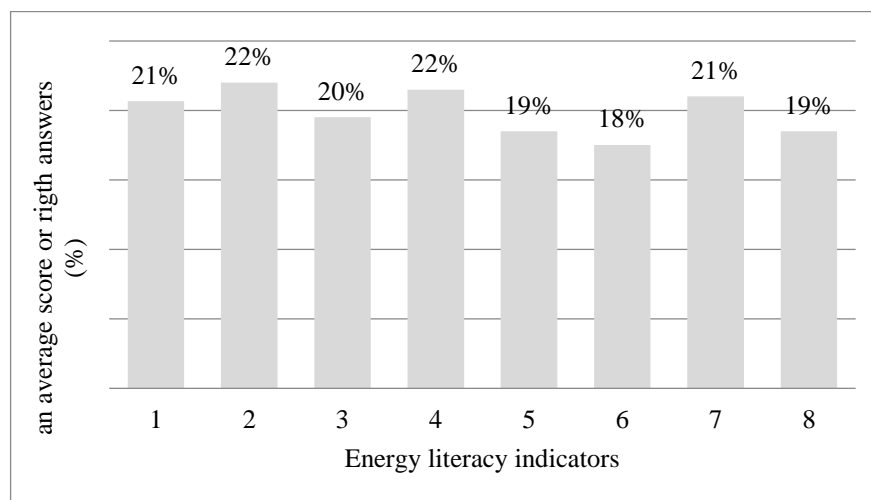


Figure 2. Percentage of average achievements per energy literacy indicators

Based on the results of testing the understanding of energy literacy obtained the average scores of energy literacy indicators are (1) basic knowledge of energy 21%, (2) understanding of energy sources and their relationship 22%, (3) awareness of the importance of energy use for individuals and social life 20%, (4) knowing trends in energy use in Indonesia and global energy sources - supply and use 22%, (5) understanding the effect of developing energy sources and applying usage in society 19%, (6) understanding the influence of sources energy and its use on the environment awareness 18%, (7) know the consequences of individual and social decisions associated with the development of energy sources as much as 21%, and (8) the ability to analyze, interpret, evaluate and test 19%.

The results from the above achievements indicate that the average cadet is at a low value based on the performance criteria of each under 30%. This result is due to the lack of interest in the learning process of cadets about energy. Building an understanding of energy for cadets has not yet touched on the need for life. Because for cadets, that energy only used without it needs to be understood and studied in-depth, so the focus of learning is still less concentrated on increasing understanding. The need for additional time in learning is conveyed to engineering cadets and do not just on one sub-material. Based on the results of the questionnaire relating to energy and energy use on the ship, as shown in Table 3.

Table 3. Results of engineering cadets response from questionnaires (N = 61)

Questions		Cadets Respon	
Q2	I will save energy if I know	Very Approve :	39 %
		Approve :	32%
		Not Approve:	3%
		Not Very Approve:	2%
		No Respons:	24%
Q3	Saving energy is essential for cadets decision	Very Approve :	66 %
		Approve :	8%
		Not Approve:	2%
		Not Very Approve:	2%
		No Respons:	24%
Q9	We should use renewable energy	Very Approve :	34 %
		Approve :	34%
		Not Approve:	5%
		Not Very Approve:	3%
		No Respons:	24%
Q11	In ships, the use of new technology with renewable energy is more critical than using petroleum.	Very Approve :	32 %
		Approve :	35%
		Not Approve:	6%
		Not Very Approve:	2%
		No Respons:	24%
Q12	Rules to protect the environment from vessel exhaust through ANNEX must be obeyed	Very Approve :	32 %
		Approve :	39%
		Not Approve:	3%
		Not Very Approve:	2%
		No Respons:	24%
Q13	Modern ships use hybrid energy from leading engine exhaust gases	Very Approve :	24 %
		Approve :	44%
		Not Approve:	6%
		Not Very Approve:	2%
		No Respons:	24%

The learning process with STEM in this research is to combine science concepts, technology utilization, engineering projects, and mathematical calculation of energy. The first lesson is that cadets are given an understanding of the use of energy in several transportations and the use of energy in buildings. Based on the results of early learning, cadets distinguish

energy sources and energy use in the future. The cadets discuss the use of fossil energy as the most significant energy source, especially in Indonesia. Next, they predict the consumption of fossil energy, which can be used up in the next few years so that new energy needs to use and environmentally friendly. The cadets write down a list of non-renewable and renewable energy sources, and the cadets determine the energy sources that can utilize for manufacturing tool product models. So they choose the use of solar energy.

In the second learning process, cadets calculate the use of electrical energy in the spaces on the ship by simulation. Calculation of electricity usage in several ship spaces to provide the ability to calculate the electricity load used for one month.

In the third stage of learning, cadets do a project that is to make a model of a product for navigation needs on the ship in the form of navigation lights with a solar energy source, and the tool can store backup energy stored in batteries. Product modeling was done to provide practical capabilities as a prospective mechanical engineer on a ship with the development of developing technology, namely the use of solar energy as renewable energy.

In the fourth lesson, the cadets calculate the process of charging voltage and electric current from a 90 Watt PV solar cell into an accumulator and calculating the process of removing the voltage and electric current from the amount of load used from the energy stored in the accumulator. The calculation process is carried out starting at 08.00 until 12.00 during the learning process.

Learning during the four meetings is given with a variety of techniques and methods ranging from providing concepts in the classroom namely the concept of science, calculating the use of electricity in the ship space through simulation of mathematical abilities, the choice of renewable energy technology tools that are technological ability, and making projects and collect data such as voltage and electric current from the charging process to batteries and the use of electrical devices, meaning technical ability as an engineer. The learning process is focused on energy and monitoring to solve energy problems on the ship. Research by Wagner et al., (2017) said that a concentration on problem-solving abilities towards energy problems through the STEM approach could be done with wind energy projects in the laboratory.

Giving questionnaires is done by answering questions given to cadets by filling online at [digilearn.akmicirebon.ac.id](http://digilearn.akmicirebon.ac.id). Cadets who fill out the questionnaire are given 30 minutes, which are accessed via a computer or mobile phone. To equalize the time the questionnaire was filled out simultaneously in the computer laboratory and CBT.

The results of the cadets gave a picture that they realized the importance of energy and saving. Some of the energy available on the ship can be used and utilized according to its function. Like the response of cadets to the use of hybrid energy sources that have been widely used in modern ships. Cadets' response to the exhaust gas rules for the environment, crude oil spills regulated in ANNEX must be obeyed. The cadets hope that education about energy education must continue to be provided and how the use of sound energy continues to be socialized, at least in learning, so that they can apply it next time.

The discussion above clearly shows that energy literacy for cadets is directed to the concepts of energy, efficiency, and critical thinking and actively participates in choosing energy (Lee et al., 2015). In this case, energy literacy is also very influential on the quantity of energy use as Brounen et al. (2013) concerns about energy use and energy conversion used in housing. The importance of energy literacy is a challenge that is being faced by society because it has an impact on life (Bybee, 2013). For this reason, it is necessary to increase the understanding of young people about the upcoming energy issue.

The role of students in competitive societies as agents of change to make decisions and actions at home, the community, and globally (Kim, 2005). Students can overcome challenging circumstances, able to critically analyze information that demands to make decisions for the benefit of their lives (Rutledge, 2005). Through the STEM approach, according to other studies that the quality of the relationship between learners and educators associated with STEM results in excellent achievements (Bryk et al., 2010). The effectiveness of STEM results in understanding material in students (Lee, 2011).

#### **4. Conclusion**

From the results of this study, the researchers concluded that the use of STEM in providing an understanding of energy literacy with the average achievement of post-test scores increased even though it was still small. However, the attitude of the cadets towards education is essential for the cadets, the energy-saving attitude on the ship, the use of renewable energy, the rules on energy use according to ANNEX must be obeyed. These results illustrate that it is necessary to continue to add additional learning time continuously so that there is an increase in the cognitive aspects of energy literacy and an increase in awareness of the attitude of cadets on the importance of saving energy and its utilization.



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